Reduction of Accidents by Pavement Grooving

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Providing and maintaining a skid-resistant surface on concrete pavements is discussed. Studies of the effect of grooving the pavement to reduce wet weather accidents were conducted. The objective of the studies was to determine the efficiency of serrations in raising the skid resistance, to determine resistance of a grooved pavement to wear and polish of traffic, and to determine the extent of reduction in wet weather accidents by serration of the pavement. Results show that pavement grooving parallel to the centerline will reduce the wet weather accident rate in low friction value areas of PCC pavements. Friction value is raised following grooving. Wear and polish of grooved areas appear to depend on characteristics of the pavement.

•PROVIDING and maintaining a skid-resistant surface is of primary importance to the proper performance of any highway. All types of pavement surface will eventually show some reduction in coefficient of friction values during their service life. This reduction is caused by wear and polish of traffic, especially by heavy trucks.

Several years ago California Division of Highways accident analysis showed that some sections of concrete freeways, especially on curves, were having an unusual number of accidents occurring during wet or rainy weather. After considering the use of acid treatment of the surface or the application of a coal tar-epoxy screening seal coat or some other thin organic overlay, it was decided to study the effect of grooving the pavement. The objectives of the program are as follows:

1. To determine the efficiency of serration in raising the skid resistance.
2. To determine the resistance of a grooved pavement to wear and polish of traffic.
3. To determine the extent of reduction in wet weather accidents in critical areas by serration of the pavement.

MEASUREMENT OF SKID RESISTANCE

The California skid tester used in determining the coefficient of friction of pavement surfaces has been previously described (1). The presently used test method is given in the Appendix. The tester has been calibrated with the towed trailer equipment constructed by R. A. Moyer of the University of California, Institute of Transportation (2). Previous studies by Moyer and others indicated that the skid-resistance value for any given surface approaches a low figure when the brakes are locked on a vehicle having smooth tread tires and traveling at speeds of 50 mph on a wet pavement. Therefore, in the correlation program, the coefficient of friction values obtained from Moyer's unit using locked wheels, smooth tires, wet pavement and a 50-mph speed were compared to our readings obtained under identical operating conditions.

We are presently using a value of $f = 0.25$ as the minimum requirement for indicating the need for remedial action, and a minimum of $f = 0.30$ for new PCC pavement. An active program is under way to study the adequacy of these values, especially the figure for remedial action. The program involves the use of recommended minimum friction values from other sources, and an accident frequency correlation with skid resistance of the pavement surface.

C. G. Giles (3) on the basis of a comprehensive accident analysis in England has provided a set of suggested values of skid resistance for use with the British portable

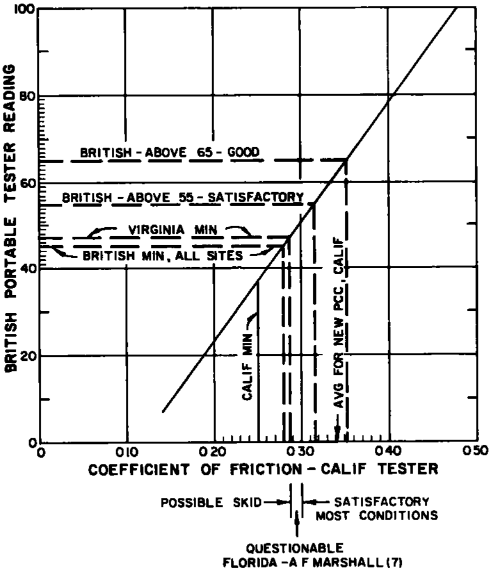


Figure 1. Correlation studies on minimum friction value for remedial action.

tester. A comprehensive correlation program was performed by us in order to obtain the relation between the California tester and the British portable tester.

On the basis of the correlation, a comparison of the recommended British values with the tentative California minimum figure is shown in Figure 1. Also shown is the Virginia minimum figure which was attained by using the correlation chart of D. C. Mahone (4) which provides an approximate correlation between the British portable tester and the Virginia test car at 40 mph.

Preliminary studies in California on a wet weather accident frequency correlation with skid resistance indicates that most single car accidents occurred on curves, the average value for the friction factor being f = 0.22. However, 28 percent of the accidents that occurred on curves were on pavements of f = 0.25-0.28 range. The maximum value attained in this study was f = 0.28.

On the basis of these results, it is concluded that the present f = 0.25 remedial action value is a minimum figure, and it appears that the value may be too low for curves of rather short radius. A better value may be f = 0.28 which is the same as the British minimum for all sites. Further studies are under way.

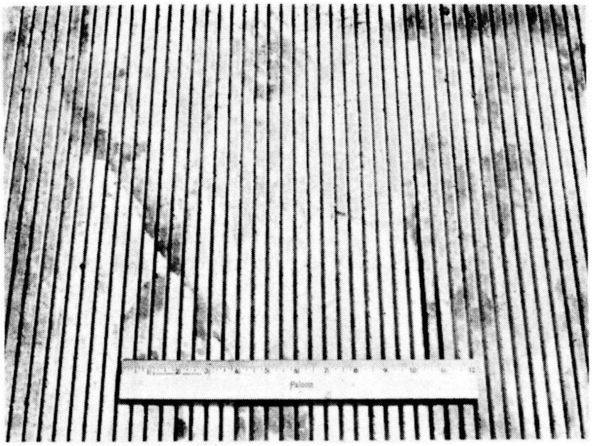
PATTERN STUDIES

Grooves may be cut in the pavement in either a longitudinal (parallel to the centerline), transverse or skewed direction. All grooving (except for a few short experimental sections) to date on state highways has been performed in a longitudinal direction. We are of the opinion that this leads to increased lateral stability, and tends to guide the vehicle through a critical curve area. This has been confirmed by studies performed in Texas (5). However, studies in England (6) indicate that grooving perpendicular to the centerline is better in this connection; further effort will be required to resolve the problem.

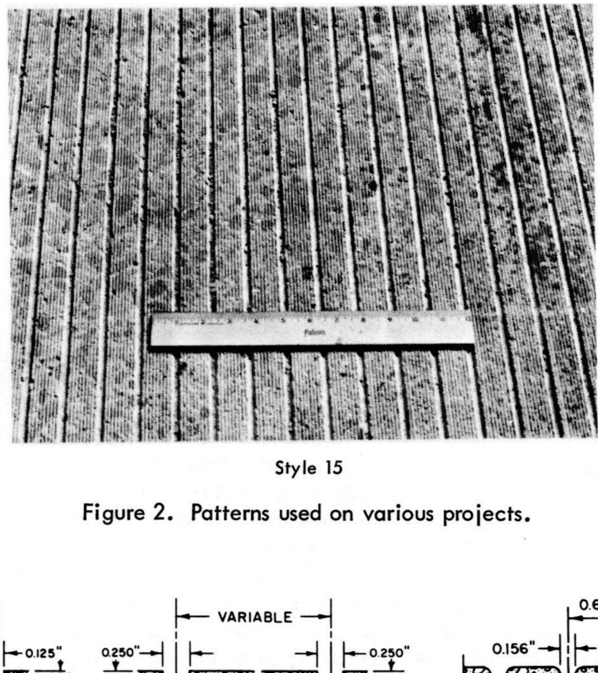
Groove patterns vary. The most common type is rectangular in form and may be varied in width and depth and distance between centers of grooves. Other types have rectangular form, but the bottom is partially rounded, and the edges at the pavement surface are also rounded. Others have a large V-cut separated by smaller V-cuts. Figure 2 shows two types of patterns.

A number of patterns have been used in our serration work to date. This was done in order to determine the increase in the friction factor, wear resistance, and possible vehicle handling problem. In all cases the grooves are all in a longitudinal direction. Figure 3 shows the patterns used on the various projects, and Table 1 gives the increase in the friction value after grooving and the change during service life. Figure 4 shows the effect of grooving on the average coefficient of friction value for the various PCC pavement projects.

In all cases the friction value is raised by pavement grooving. However, it appears that the nature of the existing concrete surface and the type of pattern affect the degree of improvement in the friction value. As an example there is a much greater improvement in the friction value for project H than on projects F and G for a ⅛ × ⅛ in. on 1 in. centers with a rectangular groove. This is also confirmed by the results from projects J and K where two different patterns are compared on two different projects.



Rectangular Grooves



Style 15

Figure 2. Patterns used on various projects.

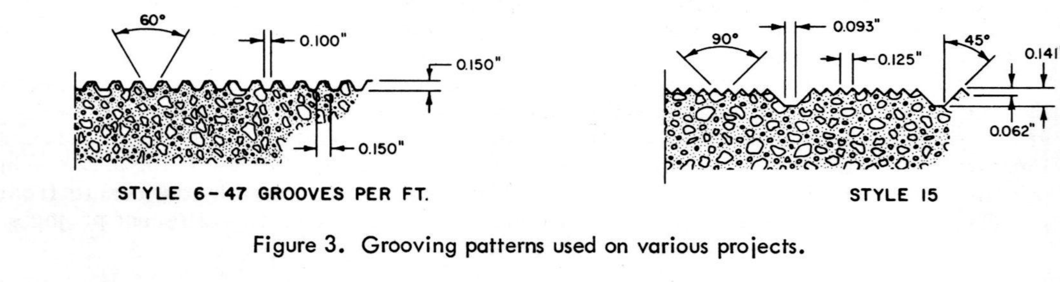


Figure 3. Grooving patterns used on various projects.

TABLE 1

CHANGE IN AVERAGE FRICTION VALUES FOLLOWING GROOVING

Project No	Pavement Type	Location	AADT/1000	Serration Pattern	Age Mos.	Avg Friction Value
A	PCC bridge deck	10-Sta-4-A	24	Rectangular grooves 1/8 in × 1/8 in. on 3/8 in centers	Before After 45 101	0.26 0.33 0.33 0.36
B	PCC bridge deck	04-Ala-7-Alb	80	Rectangular grooves 1/8 in × 1/8 in. on 3/8 in. centers	Before After 41	0.26 0.32 0.28
C	PCC	06-Kern-5-PM6 94-7 47	16	Rectangular grooves 1/8 in × 1/8 in on 3/8 in centers	Before After 67	0.19 0.32 0.34
D	PCC	07-Ora-5-PM23 3-23.6	45	Rectangular grooves 1/8 in × 1/8 in on 1/2 in. centers	Before After 17	0.25 0.35 0.30
E	PCC	07-LA-5 PM29.5-30 0	104	Rectangular grooves 1/8 in × 1/8 in on 3/4 in. centers	Before After 17	0.23 0.31 0.27
F	PCC	07-LA-405 PM2 1-2.6	131	Rectangular grooves 1/8 in × 1/8 in. on 1 in centers	Before After 17	0.20 0.24 0.22
G	PCC	07-LA-405 PM3 8-4 1	139	Rectangular grooves 1/8 in. × 1/8 in. on 1 in. centers	Before After	0.19 0.21
H	PCC	03-Pla, Nev-80 Var.	9	Rectangular grooves 1/8 in. × 1/8 in on 1 in centers		
H-1		E B lane PM42 56-42 77			Before After 12 Mo.	0.24 0.37 0.34
H-2		W B lane PM45 45-45.60	9	Rectangular grooves 1/8 in × 1/8 in on 1 in centers	Before After 12 Mo	0.25 0.32 0.29
H-3		W B lane PM5.00-5 27	9	Rectangular grooves 1/8 in. × 1/8 in. on 1 in. centers	Before After 12 Mo	0.19 0.29 0.27
H-4		E B lane PM6.55-6.65	9	Rectangular grooves 1/8 in × 1/8 in on 1 in centers	Before After 12 Mo	0.15 0.30 0.25
H-5		W B lane PM9 01-9 19	9	Rectangular grooves 1/8 in × 1/8 in on 1 in centers	Before After 12 Mo	0.19 0.30 0.27
I	AC	07-LA-101 PM8 8-9 3	134	Rectangular grooves 1/4 in × 1/4 in. on 1 in centers	Before After 17	0.23 0.28 0.29
J	PCC	07-LA-14-27 89 Placerita Canyon Bridge	13	Christensen Company Style 9	Before After	0.16 0.26
				Christensen Company Style 15	Before After	0.16 0.33
K	PCC	07-Ven-101	21	Christensen Company Style 6	Before After	0.20 0.37
				Christensen Company Style 9	Before After	0.20 0.31
				Christensen Company Style 15	Before After	0.19 0.37

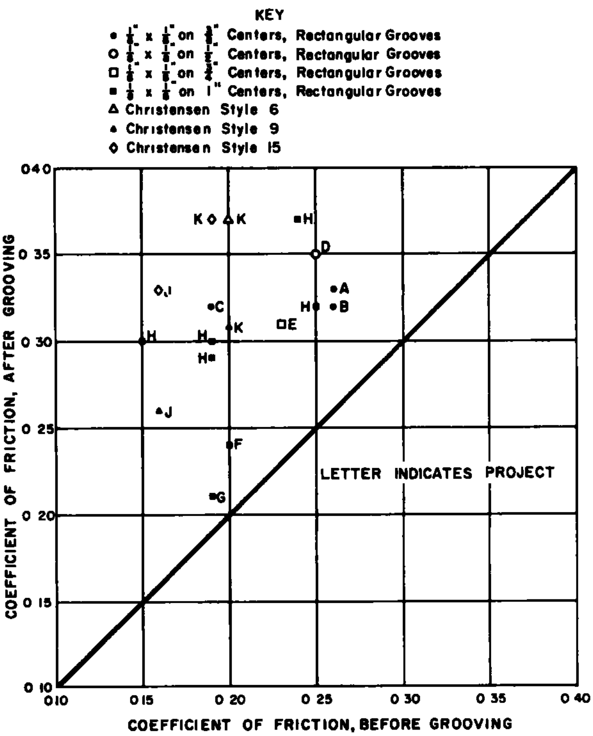


Figure 4. Effect of grooving pattern on average coefficient of friction value of PCC pavements.

The type of pattern on any specific project effects the degree of improvement. On project K, three different Christensen patterns (Table 1) were placed in consecutive 100-ft test sections in the travel lane. The original coefficient of friction values were identical, but two of the patterns produced a very high degree of improvement as compared to the third pattern.

Project I in District 07 is an aged asphalt-concrete pavement. The surface was rather dry in appearance and quite brittle. Therefore, it was decided to groove this pavement using $1/4 \times 1/4$-in. grooves on 1-in. centers. Shortly after completion several complaints were received from drivers of motorcycles and light cars. The complaints were that the vehicle tended to "track" and appeared to be caught in a manner resembling being caught in streetcar tracks. This was confirmed by highway patrolmen. On the other hand, Christensen Style 15 with V-cuts 1/4 in. wide on the Placerita Canyon Bridge provided no problems with test motorcycles driven up to 70 mph. There was some vibration up to 50 mph with Style 9, but this tended to fade out at higher speeds. Style 9 (Table 1, project J) has 3/16-in. wide rectangular grooves with rounded bottom and edges. These studies indicate that rectangular longitudinal grooves should not be wider than 1/8 in. in order to prevent possible problems from motorcycles and light passenger cars. However, V-cuts do not appear to cause problems although 1/4 in. wide at the surface.

An important characteristic of any treatment for raising the existing friction value is its resistance to wear and polish of traffic. Results of variations of friction measurements with time on various grooved projects are shown in Table 1 and Figure 5. On the majority of the projects not enough time has elapsed to draw any firm conclusions. It appears, however, that the nature of aggregate and mortar strength may influence the resistance to wear and polish of the grooved areas. However, it is interesting to note that projects A and B cover the travel lanes of heavily traveled freeways having a high percentage of trucks. All the projects shown in Figure 5 are in

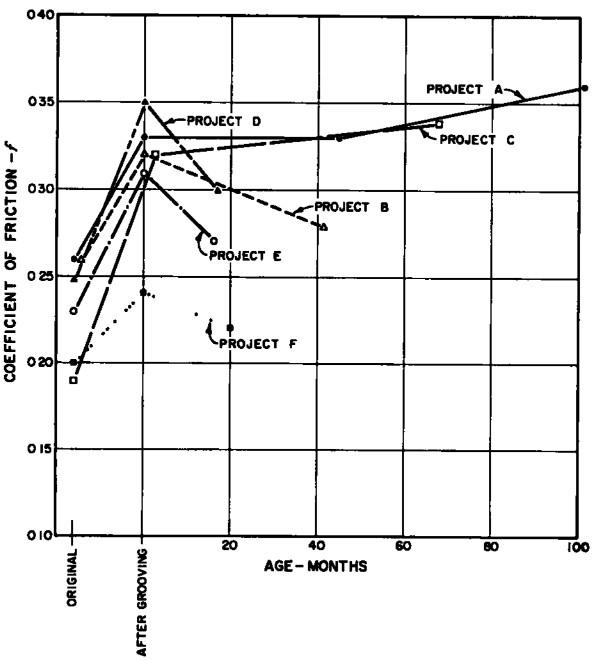


Figure 5. Change in friction values following grooving of PCC pavements.

snow-free areas. Project H (Table 1) is in a partial snow region where chains may be required. After the first winter the surface does not appear to be damaged by chain action. This project will be closely watched since project M in Table 2 has shown considerable spalling between the grooves which are on 1-in. centers. This spalling has been caused by chain action and has resulted in some complaints in regards to controllability of a car even under dry pavement conditions.

ACCIDENT STUDIES

Summaries of all of the presently available accident data are given in Tables 2, 3 and 4. Six of these locations were on urban freeways in the vicinity of Los Angeles. Accident data were also reviewed for comparison purposes on a mile of unserrated asphalt-concrete freeway (Table 4). The Los Angeles projects had one year before and after accident analysis periods. An additional project M on I-80 near the Nevada state line had a two-year period for before and after accident analysis. This freeway is rural and required longer periods to obtain meaningful data. In the case of the Los Angeles area freeways, the number of wet or rainy days was determined in both the before and after accident periods. There were 30 wet days in the before period and approximately 15 wet days in the after period. Fifteen additional wet days were accumulated from the following year and the accidents on these days were added to the after period.

Table 2 indicates that the total accidents were reduced 78 percent; of this, wet pavement accidents were almost completely eliminated (96 percent) and dry pavement accidents dropped 32 percent.

The reduction in dry weather accidents, if confirmed by further observation, appears to be significant. There is no reason to doubt that the dry friction value of these pavements was sufficiently high. In our opinion the decrease in dry weather accidents may be the result of the ability of the grooves to "track" or aid as a guide for a vehicle nearing an out-of-control condition in the curve area. Such loss of control would most commonly be caused by entering the curve at excessive speed and then rapid deceleration

TABLE 2

EFFECT ON NUMBER OF ACCIDENTS FOLLOWING GROOVING

Project No.	Location and Pvt Type	Serration Pattern	Curvature		AADT/1000	Accidents								
						Before			After			Percent Change		
			Radius (ft)	Dir		Wet	Dry	Tot	Wet	Dry	Tot.	Wet	Dry	Tot.
D	07-Ora-5 PM23.3-23.6 PCC	1/8 in. × 1/8 in on 1/2 in. centers-rectangular grooves	2000	Right	45	46	4	50	1	7	8	-98	+75	-84
E	07-LA-5 PM29 5-30 0 PCC	1/8 in × 1/8 in. on 3/4 in. centers-rectangular grooves	2000	Left	104	12	6	18	2	2	4	-83	-67	-78
L	07-LA-10 PM22.6-22 8 PCC	1/8 in. × 1/8 in. on 3/4 in centers-rectangular grooves	1020	Left	164	26	16	42	0	6	6	-100	-63	-86
F	07-LA-405 PM2 1-2.6 PCC	1/8 in × 1/8 in. on 1 in centers-rectangular grooves	Tangent		131	21	9	30	0	11	11	-100	+22	-63
G	07-LA-405 PM3 8-4 1 PCC	1/8 in × 1/8 in on 1 in centers-rectangular grooves	3000	Right	139	4	6	10	0	4	4	-100	-33	-60
M	03-Nev-80[a] PM19.8-20 2 PCC	1/8 in × 1/8 in. on 1 in. centers-rectangular grooves	1400	Left	9	5	9	14	0	6	6	-100	-33	-57
N	07-LA-101 PM8 8-9 3 AC	1/4 in × 1/4 in. on 1 in centers-rectangular grooves	2050 2052	Reversing	134	139	55	194	6	35	41	-96	-36	-79
Total						253	105	358	9	71	80	-96	-32	-78

[a]Two year before and after period, all others one year

TABLE 3

EFFECT ON ACCIDENT RATE FOLLOWING GROOVING

Project No	Pvt Type	U-Urban R-Rural	State Avg Acc Rate	Before						After					
				Wet		Dry		Total		Wet		Dry		Total	
				MVM[a]	Rate[b]	MVM	Rate	MVM	Rate	MVM	Rate	MVM	Rate	MVM	Rate
D	PCC	R	1 00	0.18	255 56	1 96	2.04	2 14	23 36	0.20	5 00	2.26	3 10	2 46	3.25
E	PCC	U	1.61	0.77	15 58	8.54	0.70	9 31	1 93	0.78	2.56	8.71	0.23	9.49	0.42
L	PCC	U	1 61	0 49	53 06	5 46	2 93	5.95	7 06	0.49	0.00	5 50	1 09	5 99	1 00
F	PCC	U	1.61	0 97	21 65	10 80	0 83	11 77	2 55	0.98	0 00	10 97	1 00	11 95	0 92
G	PCC	U	1 61	0 59	6.78	6 64	0 90	7 23	1 38	0 63	0.00	6 98	0.57	7 61	0 53
M	PCC	R	1 00	—	—	—	—	1 02	13 73	—	—	—	—	1.31	4.58
I	AC	U	1.61	2 04	68 14	22 78	2 41	24 82	7 82	2.01	2.99	22 45	1.56	24 46	1 68
Total for PCC Pvts.			1 48	3 00	36.33	33.40	1 23	37 42	4 38	3 08	0 97	34.42	0 87	38 81	1.00

[a] MVM = million vehicle-miles
[b] Rate = number of accidents – MVM

TABLE 4

COMPARISON OF NUMBER OF ACCIDENTS ON GROOVED AND CONTROL ASPHALT-CONCRETE PAVEMENT

Project No.	Location and Pvt Type	Serration Pattern	Curvature		AADT/1000	Accidents								
			Radius (ft)	Dir.		Before			After			Percent Change		
						Wet	Dry	Tot.	Wet	Dry	Tot.	Wet	Dry	Tot
I-1	07-LA-101 PM7 8-8 8 AC	No serration (control)	Var	Reversing	123	36	59	95	41	75	116	+14	+27	+22
I	07-LA-101 PM8 8-9 3 AC	¼ in. × ¼ in. on 1 in centers-rectangular grooves	2050 2052	Reversing	134	139	55	194	6	35	41	-96	-36	-79

within the curve area. Such action could cause loss of control. The longitudinal grooves by acting as tracks could resist lateral movements and add stability to the vehicle. In the case of the wet pavement condition we may, therefore, assume that longitudinal grooving in curve areas not only increases the friction factor, but also acts as a stabilizer against lateral instability. It probably also serves as a quick surface drain to minimize any water buildup on the pavement.

Table 3 gives the exposure in million vehicle-miles, accident rates, and other information. Both wet and dry pavement accident rates were calculated relative to the number of wet or dry days. These rates could not be calculated at the I-80 location, project M, since the number of wet days was not available.

All of the accident rates on wet days were much higher than the average state highway rates at both urban and rural locations. Because there are relatively few wet days per year in southern California, the resulting exposure is small. When this is divided into the overall large number of accidents occurring on wet pavement, the result is an unusually high rate. All locations (excepting one) had higher than average total accident rates in the before grooving period. The concrete surfaced urban freeways all had below average (< 1.61) rates in the after period. The two rural locations (both concrete surfaced) still had higher than average total accident rates (>1.00) despite sizable drops in rates after pavement serration.

For comparison purposes the accident rate on a one mile stretch of asphaltic-concrete pavement just south of the serrated project N was compared with the unserrated control section. The results are given in Table 4 and clearly indicate the excellent reduction in wet weather accidents following grooving. In the same period the control section had a gain in wet weather accidents.

It is proposed to continue this accident analysis, and periodical skid-resistance surveys to determine possible increase in accidents as the friction values change during service life.

COST OF GROOVING

On seven jobs in District 07 the cost of grooving was in the range of \$0.07 to \$0.09 per sq ft. In some other districts the cost is somewhat higher. The best estimate is approximately \$0.10 per sq ft.

SUMMARY

In summary, it appears that pavement grooving performed in a direction parallel to the centerline will definitely reduce the wet weather accident rate in low friction value areas of PCC pavements. Excellent reduction of wet weather accidents occurred after grooving of an old asphalt-concrete pavement. However, this pavement was very hard and brittle, and we do not recommend grooving of normal asphalt-concrete pavement, since kneading by traffic may rapidly close the grooves. It seems preferable to apply a screening seal coat, slurry seal coat or dense or open-graded blanket.

The friction value is raised following grooving. The rate of change in friction value by wear and polish of the grooved area appears to depend on the characteristics of the original concrete pavement, since two pavements with heavy truck traffic showed little change in friction values after a number of years of service. On the other hand, some pavements show quite rapid drops after only 17 months of traffic. Further tests are required.

Motorcycle and light car tests clearly indicate that ¼- × ¼-in. grooves will create problems in vehicle control. It is recommended that cuts no greater than ⅛- × ⅛-in. be used if vertical grooves are cut in the pavement. However, ⅛-in. deep × ¼-in. wide V-grooves do not appear to create any problems. Further studies are required before any specific spacing may be recommended. However, since approximately equal accident reductions were noted for ½- and ¾-in. spacing, it is recommended that ⅛ × ⅛ in. on ¾-in. centers be used. It is highly desirable that further areas be grooved with a series of patterns as was done on the Ventura project in order to determine effectiveness in raising the original coefficient of friction, and resistance to wear and polish under equivalent concrete and traffic conditions.

ACKNOWLEDGMENT

This paper is based on data collected during a research project financed by the U. S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads. The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Bureau of Public Roads.

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Appendix

State of California
Department of Public Works
Division of Highways

MATERIALS AND RESEARCH DEPARTMENT

Test Method No. Calif. 342-C
October 3, 1966

METHOD OF TEST FOR PAVEMENT SURFACE SKID RESISTANCE

Scope

This method describes the apparatus and procedure for obtaining surface skid resistance values of Bituminous and Portland Cement Concrete pavements

Procedure

A. Apparatus

1 Skid test unit

a Reference is made to Figures I through III in connection with the following description of the construction of the test unit A 4 80/4 00 x 8, 2-ply tire with (25 ± 2 psi) air pressure (A), manufactured with a smooth surface, together with rim, axle and driving pulley is mounted on a carriage (B) The tire is brought to desired speed by motor (H) The carriage moves on two parallel guides (C), and the friction is reduced to a low uniform value by allowing three roller bearings fitted at 120° points to bear against the guide rod at each corner of the carriage The bearing assembly may be noted on Figure III (D) The two guide rods (C) are rigidly connected to the end frame bars (E) The front end of this guide bar frame assembly is firmly fastened to a restraining anchor The bumper hitch provides for swinging the skid tester to the right or left after positioning the vehicle The rear end of the frame assembly is raised by a special adjustable device (F), Figure II, so as to hold the tire ¼-inch off the surface to be tested This device is so constructed that the tire may be dropped instantaneously to the test surface by tripping the release arm (G), Figure II Tachometer (K) indicates the speed of the tire

2 Hitch for fastening unit to vehicle

3 Special level to determine grade of pavement

a A 28" long standard metal carpenter's level Fig IV, is fitted at one end with a movable gauge rod which is calibrated in % of grade

B. Materials

1 Glycerine
2 Water
3 2-inch paint brush
4 Thickness gauge ¼-inch (a piece of ¼-inch plywood 2' x 1" is satisfactory)

C Test Procedure

1 Determine and record grade with special level, see Fig IV

a Place level on pavement parallel to direction of travel with adjustable end down grade

b Loosen locking screw and raise level until bubble centers and then tighten locking screw on sliding bar

c The grade is indicated on the calibrated sliding bar

2 Remove apparatus from vehicle and attach to bumper hitch, Fig V

3 Position apparatus with tire over selected test area and parallel to direction of traffic

4 Raise tire and adjust to ¼-inch (1/16" tolerance) above surface to be tested with device (F)

5 Wet full circumference of tire and pavement surface under tire and 16" ahead of tire center with glycerine, using a paint brush

6 Set sliding gauge indicator (P) against carriage end
7 Depress starting switch (J) and bring the speed to approximately 55 mi/hr
8 Release starting switch
9 The instant the tachometer shows 50 mi/hr trip arm (G) dropping tire to pavement
10 Read gauge (N) and record
11 Release rebound shock absorber
12 Move to next section and repeat
13 In any one test location, test at 25′ intervals in a longitudinal direction over a 100′ section of pavement

D. Precautions

1 The rear support rod (O), Fig II, must be cleaned by washing frequently with water and a detergent to prevent sticking

2 Sliding gauge indicator (P) must be kept clean so that it will slide very freely

3 On slick pavements glycerine remaining on the pavement should be flushed off with water to prevent possible traffic accidents

E. Field Construction Testing of Portland Cement Concrete Pavement

The following procedure shall be followed in the field testing of a portland cement concrete pavement for specification compliance of the minimum friction value A minimum of seven days after paving shall lapse before testing

1 Visually survey the total length of pavement for uniformity of surface texture Note all areas which do not have definite striations or which appear smooth Conduct this survey with the Resident Engineer or an Assistant who has knowledge of any difficulties in attaining a proper surface texture during construction. The attached photograph, Figure VIII, may be used as an aid in the evaluation of the existing texture in relation to the coefficient of friction, but is not to be used in lieu of actual coefficient of friction measurements

2 The determination of test locations, as outlined below, *shall apply only to that portion of the pavement which has well formed striations All areas that appear smooth, or those that have been ground shall be excluded* (See E-3 for procedure to follow for smooth pavements).

a Select a minimum of three test locations for each day's pour and check a minimum of three pour days per contract

Determine the location of test sites in a random manner through use of a Random Number table The use of this method requires that the area for test be uniformly textured and placed in one operation As an example, a 4-lane pavement may be placed with a three lane width in one operation and the fourth lane placed separately Each of these areas must be treated separately in selecting test locations The following example illustrates the use of this table

A section of pavement is 24′ wide and 4000′ long and is part of a 4-lane freeway This section of pavement has been placed in one operation and skid tests are required From 2-a, it is required that three test locations be determined

Using the random numbers, as shown choose the three locations in the following manner

Longitudinal	*Random Numbers Lateral*
0 6	6
0 9	9
0 2	2
0 7	7
0 5	5
0 1	11
0 4	4
0 8	8
0 3	3

Starting at any point and proceeding up, or down, but not skipping any numbers, read three pairs of numbers and set up each location as follows

	Distance from Start of Pour	*Distance from Right Edge of Pour Looking up Station*
Location A	0 6 × 4,000′ = 2,400′	6 × 2 = 12′
Location B	0 9 × 4 000′ = 3,600′	9 × 2 = 18′
Location C	0 2 × 4,000′ = 800′	2 × 2 = 4′

In case any location as determined above falls in a smooth or ground area which does not appear representative of the general surface texture, then choose the next number in the random table and select a new location

At each test location obtain the first reading at the specified random location (using the method described under C-Test Procedure) Obtain the next four readings at 25′ intervals beyond the first reading Obtain all readings at sites parallel to the centerline of the lane After correction for grade as shown in F, average the five readings Record this average as the friction value for the specific test location

3 In all areas that present a smooth textured appearance or have been ground, the following shall apply

a Check a minimum of three ground area locations and all smooth appearing surfaces on each contract

b If the area is less than 100′ in length perform at least three individual tests in separate spots, correct for grade and average the results

c If the area is greater than 100′ in length, select sufficient test locations to insure that the area is above the minimum requirement If the average value of all locations is below the required minimum then perform additional tests until the area is localized for remedial action

F Calculations

1 Make grade corrections using charts shown in Figures VI and VII

2 Average the 5 corrected readings in any one test location *Example*—The following readings were taken at 25′ intervals in a test location The grade of the pavement, determined as described in C-1, was +4%

Station	*Measured Coefficient of Friction*	*Corrected Coefficient of Friction**
1+00	0 33	0 38
1+25	0 34	0.39
1+50	0 34	0.39
1+75	0 33	0 38
2+00	0 33	0 38
Final Average for Test Site		0 38

* Corrected coefficients of friction were taken from chart in Figure VI

G. Reporting of Results

For all results determined under E-2, report the result for each station location and the average of 5 readings and the grand average For all results determined under E-3, part (b), report the result for each station location and the average For E-3, part (c), report the result for each station location and the average for each set of five determinations

REFERENCE
A California Method

End of Text on Calif 342-C

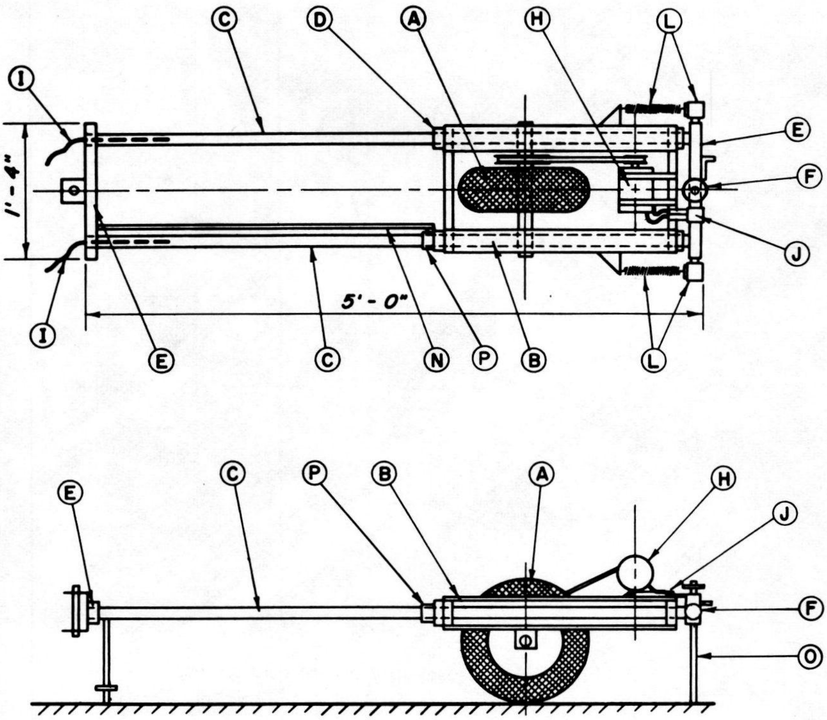

Figure I. Diagram of skid tester.

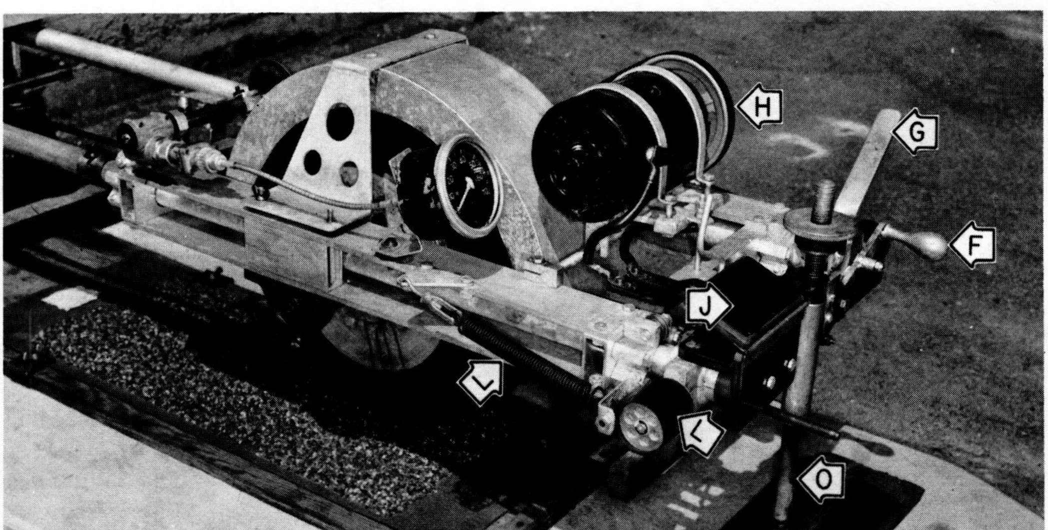

Figure II. Close-up views of skid tester.

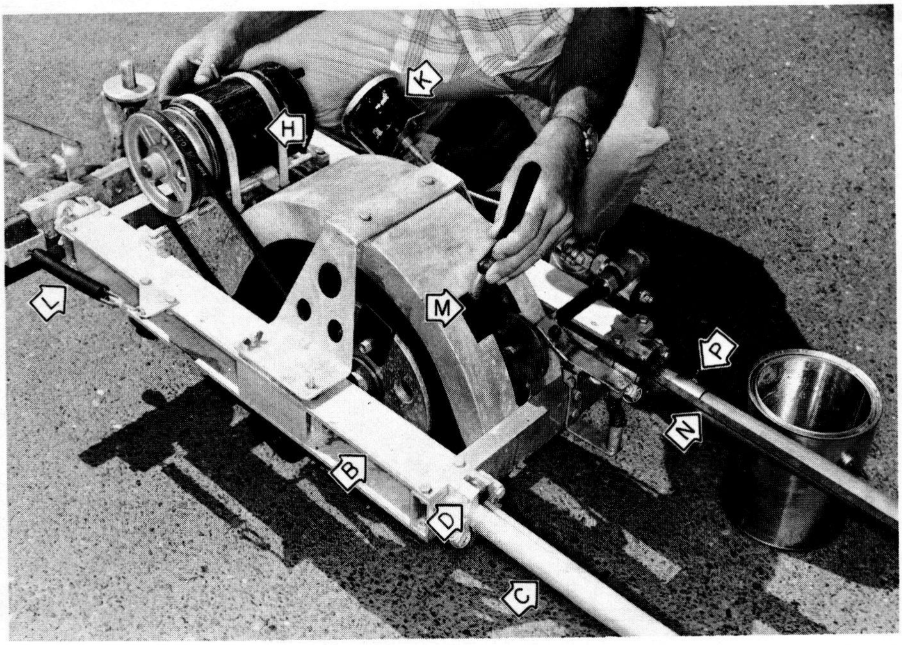

Figure III. Close-up views of skid tester.

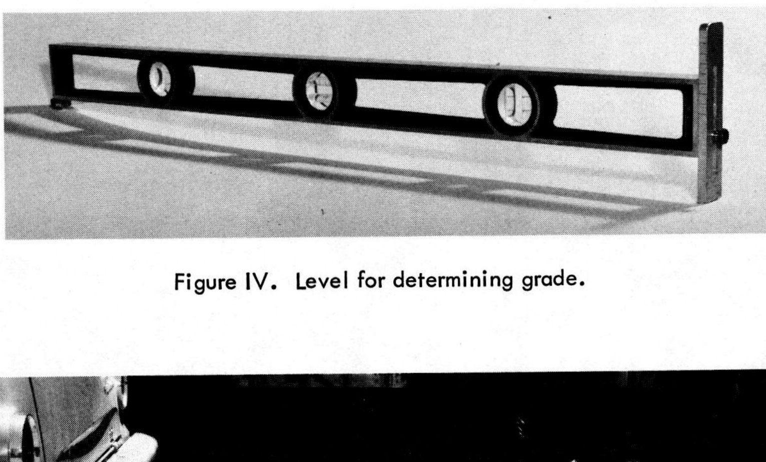

Figure IV. Level for determining grade.

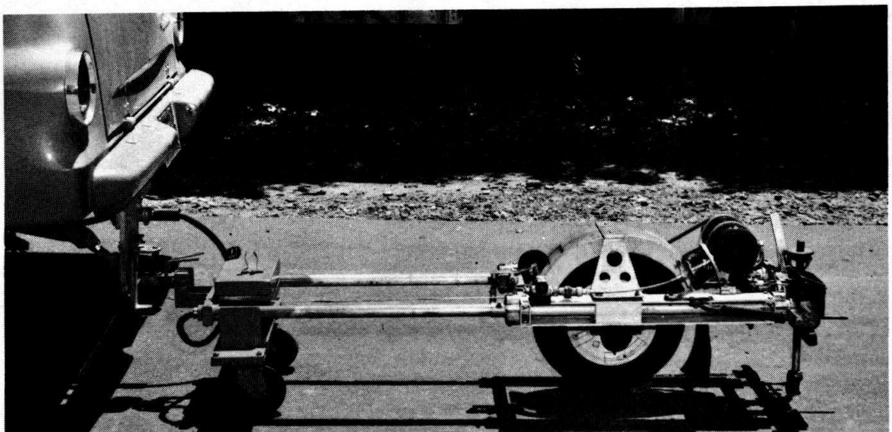

Figure V. Apparatus in position for testing.

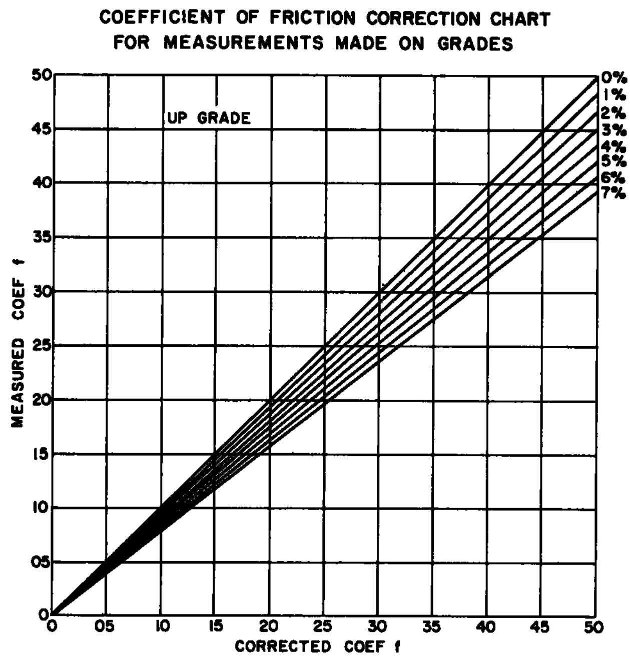

Figure VI. Coefficient of friction correction chart for measurements made on grades.

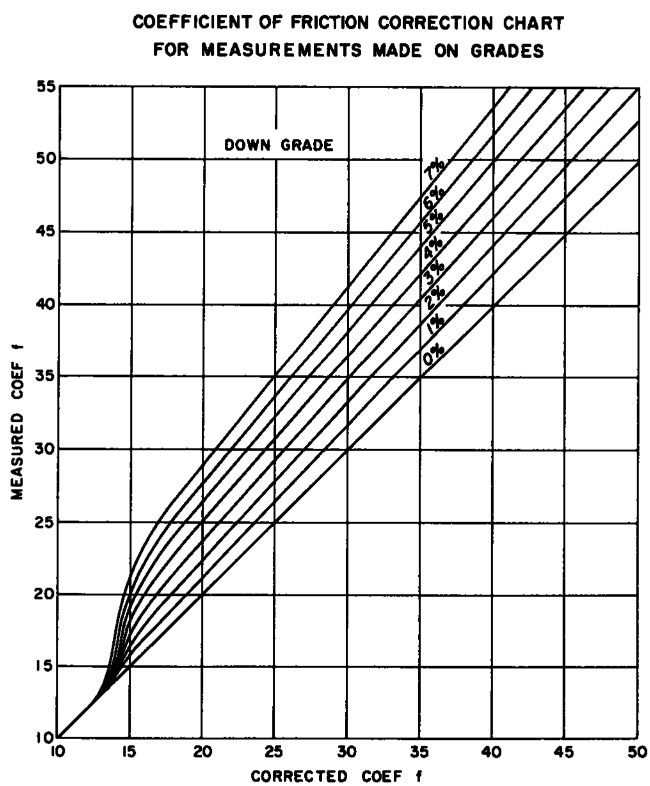

Figure VII. Coefficient of friction correction chart for measurements made on grades.

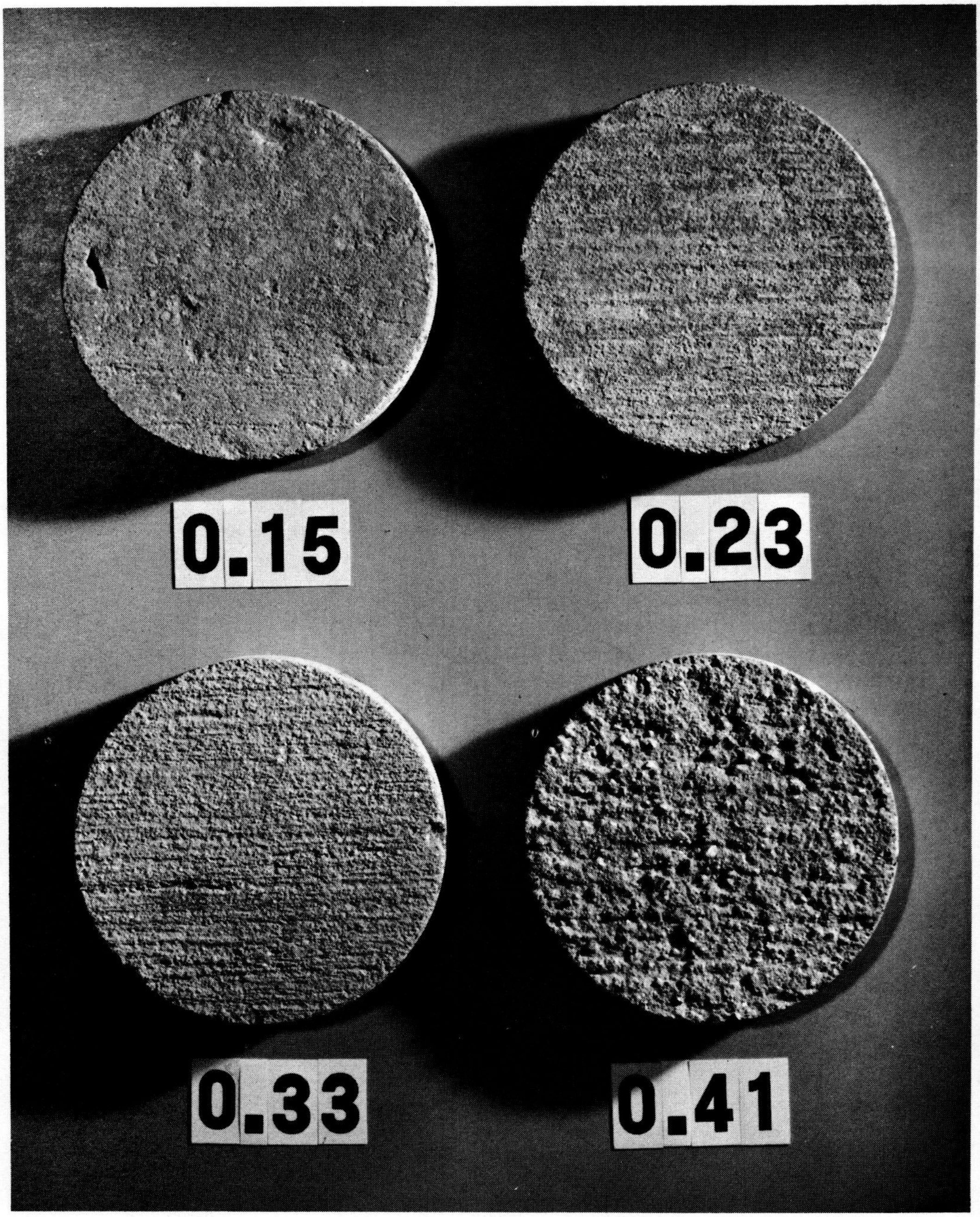

Figure VIII. Photos of surface textures.

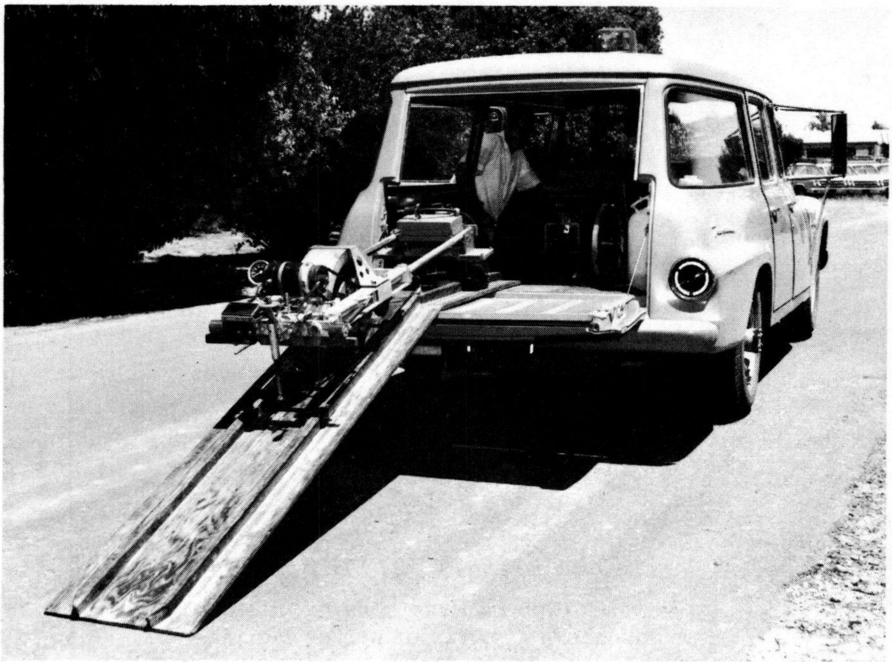

Figure IX. Apparatus being placed in vehicle; note cable and winch for moving skid tester.

Figure X. Apparatus in position for transportation.